Limnological investigations of small water bodies in the Pilis Biosphere Reserve, Hungary
Part II. Kőhegyi-tó and Unkás-tócsa

By

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Abstract. The regular limnological investigation of small, lentic, forest water bodies in the Pilis Biosphere Reserve began in 1998. The water chemistry and the Crustacea (Cladocera, Ostracoda, Copepoda) fauna of these waters are studied seasonally. Twenty-six and seven Crustacea species were recorded in the Kőhegyi-tó (Kőhegyi-Lake) and the Unkás-tócsa (Bombina Pond), respectively. The ostracode *Heterocypris reptans* recorded from the Unkás-tócsa is new to Hungary. The Kőhegyi-tó has the most diverse and abundant Cladocera communities among the investigated ponds. A few Cladocera species (e.g. *Ceriodaphnia dubia, Kurzia latissima, Diaphanosoma brachyurum, Alona quadrangularis*) have been detected only in this pond.

The Pilis Biosphere Reserve is situated northwest to Budapest in the Pilis and the Szentendre-Visegrádi Mountains, and has an extent of 23,000 hexctares. The two mountains are diverse in geological and geographical respect, the Pilis is mainly formed from Triassic limestone, the Szentendre-Visegrádi Mountains is volcanic, predominantly consisting of andesite.

The regular, systematic survey of streams and small water bodies in the Pilis Biosphere Reserve started in 1982 (Berczik, 1984). The basic limnological investigations of small water bodies began in 1998 (Kiss, 2000). Our study included the determination of the most important water chemistry and environmental parameters, as well as the species composition of the Crustacea (Cladocera, Ostracoda, Copepoda) fauna in twenty-one small waters. The general environmental description, the water chemistry field-work measurements, the presentation of the Crustacea fauna as well as the synthetic evaluation of former publications were carried out by the author, and the results of the water chemical laboratory analyses were derivedfrom M. Gánti-Papp. In this paper we present our data of the adjacent Kőhegyi-tó and Unkás-tócsa, considering that about former conditions of these two ponds several scientific data have been published.

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General description of the study area

The Kőhegyi-tó and the neighbouring Unkás-tócsa are situated on the top of the Kő-hegy (Kő-Mountain) at 366 m above sea-level, north to Pomáz, in the southern part of Szentendre-Visegrád Mountains (Fig. 1). They are temporal forest water bodies. The Kőhegyi-tó can be found in a round depression and fed by precipitation. In spring it also gets water from a side arm of the Bükkös Stream. The lake is surrounded by a *Querco-petraeae-Carpinetum* forest and a wide *Phragmites* and *Carex* belt with occasional *Salix* and *Pinus* individuals. The water surface is nearly completely covered by aquatic macrophytes (mainly by *Lemna minor* L., *Spirodela polyrrhiza* (L.) Schleid, *Myriophyllum verticillatum* L. and *Polygonum amphibium* L.). Its surface area reached 120 × 70 m with a 90 cm water depth in spring, 2000. The Kőhegyi-tó very rarely dries out, it was wet even during the dry summer of 2000.

The Unkás-tócsa is a shallow temporal water body, which usually dries out completely in summer. It is located approximately 200 m away from Kőhegyi-tó in the meadow next to Kőhegy Tourist Lodge, and fed only by precipitation. Its largest surface area was 15 × 20 m in 1999–2000. Only one *Carex* sp. and small filamentous algae colonies were found in this ephemeral water, which was named after the Fire-bellied toad (*Bombina bombina*) visiting this pond in large number when it is wet.

Considerable human impact, mainly trampling affects both water bodies due to the neighbouring tourist lodge. Increased tourism might also have played a role in the complete disappearence of *Sphagnum* species and *Nuphar* from the Kőhegyi-tó, where it existed earlier (Nógrády, 1962).

Previous studies

Palik (1941) sampled the algae communities of Kőhegyi-tó several times in 1941, she detected 61 algae species. She also investigated the Tólaki-láp lying 1800 m away from this site a year earlier (Palik, 1940). Both water bodies are fed by precipitation, their pH and conductivity were low. Palik (1940) detected different *Sphagnum* species in the Tólaki-láp. A number of species indicating low pH and bog-like conditions, mainly from the genera *Cosmarium*, *Staurastrum* and *Closterium* of the Desmidiales order, were described from both waters. A high number (22) of species lived in both habitats while several peat-related algae species (e.g. *Closterium lineatum* Ehrenb., *C. jenneri* Ralfs, *Cosmarium speciosum* Lund., *Staurastrum striolatum* Arch. and *Characium braunii* Bruegger) existed only in the Tólaki-láp.

Nógrády (1962) studied the Rotifera, Gastrotricha, Cladocera and Copepoda fauna of Kőhegyi-tó in 1956 from June to October every month. He

classified Kőhegyi-tó as a peat bog, because he found *Sphagnum* patches in the reed and *Carex* weed belt around the lake. During his studies the water surface reached 100 × 100 m with a 120 cm water depth. A *Nuphar* stand covered the middle of the lake. He recorded fifty-one Rotatoria, five Gastrotricha, twenty Cladocera and six Copepoda taxa from the lake

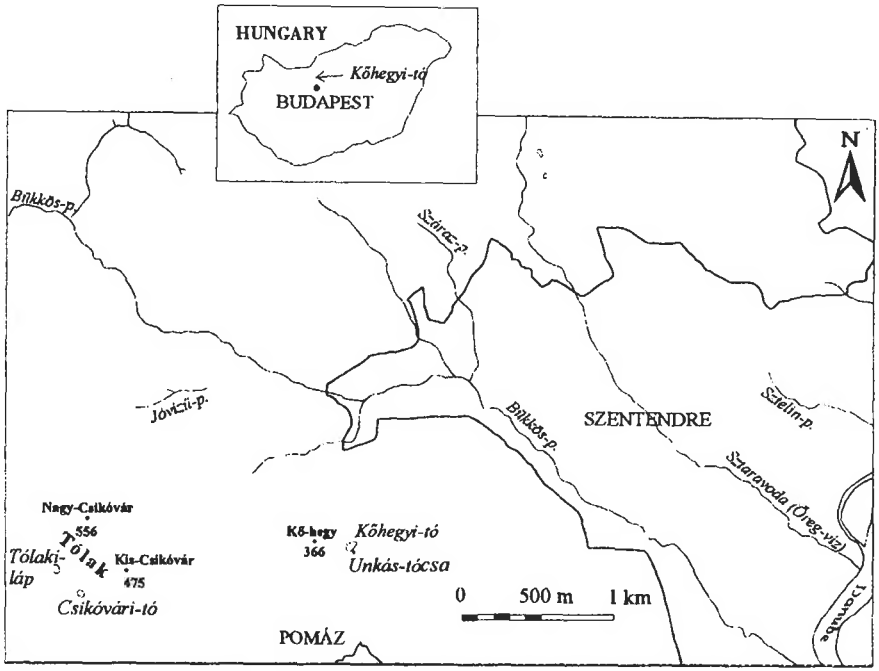

Fig. 1. The study area

including two new Rotatoria species, *Cephalodella conica* and *Lecane urna*. Among Cladocera, he also found *Alona protzi*, which had only been known from Lake Balaton, Hungary, and *Graptoleberis testudinaria* and *Daphnia magna* which are very rare in the small water bodies of the Pilis Mountains.

Methods

Water chemistry measurements were carried out in the middle of the open water areas of the ponds, zoological samples were collected from different microhabitats (open water, floating macrophytes, reeds, weed, logs, roots, rocks, etc.). Six seasonal sampling was carried out between 1999 and

Table 1. Water chemistry data of the Kőhegyi-tó and Unkás-tócsa. (1941 and 1956 data were published by Palik (1941) and Nógrády (1962); 1999-2000 data were derived from bthe author)

	Date	Kőhegyi-tó	Unkás-tócsa
Water surface (m)	23. 09.1956	100x100	
	15. 04.1999	110x70	20x15
	05. 08.1999	100x60	15x8
	31. 10.1999	95x55	dried out
	17. 04. 2000	120x70	15x10
	28. 08. 2000	15x10	dried out
	15. 10.2000	5x3	dried out
pH	06.1941	5.8-6.3	
	09.1941	5.5	
	23. 09. 1956	5.8	
	15. 04. 1999	6.86	7.41
	05. 08.1999	6.45	7.14
	31. 10. 1999	5.73	dried out
	17. 04. 2000	6.92	7.38
	28. 08. 2000	6.66	dried out
	15. 10.2000	9.09	dried out
Conductivity	15. 04. 1999	132	125
(μS/cm)	05. 08. 1999	118	210
	31. 10. 1999	82.5	dried out
	17. 04.2000	91.5	98
	28. 08. 2000	166	dried out
	15. 10. 2000	253	dried out
Dissolved oxygen	23. 09. 1956	7.1	
(mg/l) and	15. 04. 1999	9.63 (92%)	12.35 (137%)
saturation	05. 08. 1999	4.55 (54%)	8.93 (105%)
	31. 10. 1999	3.5 (31%)	dried out
	17. 04. 2000	10.35 (110%)	14.79 (177%)
	28. 08. 2000	14.84 (170%)	dried out
	15. 10. 2000	18.5 (214%)	dried out

2000 (15. 04. 1999, 05. 08. 1999, 31. 10. 1999, 17. 04. 2000, 28. 08. 2000 and 15. 10. 2000). Water chemistry parameters were measured with a portable WTW Multiline-P4 multifunctional field equipment. Temperature, pH, conductivity, dissolved oxygen concentration and oxygen saturation were recorded.

Table 2. Water chemical characterisation of the Kőhegyi-tó. (The new analyses were made by M. Gánti-Papp, Hungarian Danube Research Station of the Hungarian Academy of Sciences)

	Kőhegyi-tó 23. 09. 1956 (Nógrády, 1962)	Kőhegyi-tó, 17. 04. 2000
Suspended matter (mg/l)		5.0
Total dissolved solids (mg/l)		17
Turbidity (mg/l)		35
Alkalinity (W^0)	0.2	1.01
Total hardness (nk^0)	2	3.25
Ca hardness (nk^0)	2	1.81
Mg hardness (nk^0)		1.44
HCO_3^- concentration (mg/l)		60.39
CO_3^{2-} concentration (mg/l)		0.0
Ca^{2+} concentration (mg/l)	14	12.97
Mg^{2+} concentration (mg/l)	0.0	6.27
NO_3^- concentration (mg/l)		0.0
PO_4^{3-} concentration (mg/l)		0.03
SO_4^{2-} concentration (mg/l)	0.0	0.0
Total chemical oxygen demand (mg O_2/l)		29.61
COD of dissolved matter (mg O_2/l)		25.85
COD of particulated matter (mg O_2/l)		3.76

Qualitative samples were collected from all possible microhabitats with a 70 µm mesh size net to get a general overview of the Cladocera, Ostracoda and Copepoda fauna of the ponds. They were fixed in a 4% formaldehyde solution on the site.

Result and discussion

Water chemistry

The Kőhegyi-tó is a slightly acidic bog-like water body, rich in dark humic acids, with low conductivity, HCO_3^- and Ca^{2+} ion dominance (Tables 1 and 2). Its pH has moderately increased since Palik (1941) and Nógrády (1962) studied the lake, probably due to the pollution of the nearby tourist lodge. From summer 2000, the pH considerable increased due to water less through evaporation, a large number of filamentous algae and a large amount of wild

boar droppings. The intensive proliferation of filamentous algae resulted in a high concentration of dissolved oxygen in 2000.

Cladocera, Ostracoda and Copepoda fauna

Altogether 29 Crustacea species (19 Cladocera, 5 Ostracoda, 5 Copepoda) were recorded from the two ponds between April, 1999 and October, 2000 (Table 3).

	Kőhegyi-tó	Unkás-tócsa	Species present in both water bodies
Cladocera	18	2	1
Ostracoda	3	3	1
Copepoda	5	2	2

Of the twenty-one investigated forest water bodies, the Kőhegyi-tó had the highest Crustacea, and within them, Cladocera species number in the Pilis Biosphere Reserve. *Diaphanosoma brachyurum, Ceriodaphnia dubia, Kurzia latissima* and *Alona quadrangularis* were only recorded from there. Probable causes for the species richness are the stability of the aquatic habitats and the presence of diverse microhabitats, due to different macrophyton stands. *Moina brachiata,* which had been detected by Nógrády (1962), could not be found again in the Kőhegyi-tó in 1999-2000 though it was common in the Unkás-tócsa, which is only 200 m away. In that water body only seven Crustacea species were sampled in low abundance.

However, a small parthenogenetic population of *Heterocypris reptans,* a new Ostracoda species for Hungary, was first recorded from this temporal pond in April, 2000. It is known from several Central and Southern European countries (Slovakia, Slovenia, Croatia, Macedonia, Bosnia, France, Italy) with a northern distribution in Poland and a small population in Algeria (Meisch, 2000). Sexually reproducing populations have only been found in Croatia and Israel (Martens, 1996) so far. This phenomenon was described in several Ostracoda species. It is probably the effect of Ice Ages, when a lot of Ostracoda species disappeared from North Europe and moved to the Mediterranean. After the ice had retreated, only parthenogenetic populations could recolonise the northern areas while sexually reproducing ostracode populations survived in isolated Mediterranean refuges as relict populations.

Two common and abundant forest pond Ostracoda species (*Cyclocypris ovum* and *Cypria ophtalmica*) were missing from these ponds, probably due

*Table 3. The Cladocera, Ostracoda and Copepoda species in the Kőhegyi-tó and Unkás-tócsa. (++= abundant, += relatively abundant, (+)= low individual number, *= species also recorded by Nógrády, 1962)*

Species	Kőhegyi-tó	Unkás-tócsa
CLADOCERA		
Diaphanosoma brachyurum (Liévin)	(+) *	
Daphnia obtusa Kurz	+	
Daphnia longispina O. F. Müller	(+) *	
Simocephalus exspinosus (Koch)	++ *	
Simocephalus vetulus (O. F: Müller)	+	
Moina brachiata (Jurine)	*	++
Ceriodaphnia reticulata (Jurine)	+ *	++
Ceriodaphnia dubia Richard	(+)	
Ceriodaphnia laticaudata P. E. Müller	(+)	
Scapholeberis mucronata (O. F. M.)	(+) *	
Kurzia latissima (Kurz)	++ *	
Tretocephala ambigua (Lilljeborg)	(+)	
Oxyurella tenuicaudis (Sars)	(+) *	
Alona intermedia Sars	(+) *	
Alona quadrangularis (O. F. M.)	(+) *	
Alona affinis (Leydig)	(+)	
Alonella excisa (Fischer)	++	
Alonella exigua (Lilljeborg)	(+)	
Chydorus sphaericus (O.F. Müller)	++ *	
OSTRACODA		
Notodromas monacha (O. F. Müller)	+	
Heterocypris reptans (Kaufmann)		(+)
Cypridopsis vidua (O.F. Müller)	(+)	
Cypridopsis elongata (Kaufmann)		(+)
Sarscypridopsis aculeata (Costa)	(+)	(+)
COPEPODA		
Canthocamptus staphylinus (Jurine)	(+)	
Eudiaptomus vulgaris (Schmeil)	(+) *	
Eucyclops serrulatus (Fischer)	+	(+)
Cyclops strenuus strenuus Fischer	+	+
Megacyclops viridis (Jurine)	++ *	

to their isolation (the nearest Tólaki-láp is 1800 m away) and geographical location (mountain peak surrounded with steep, forested slopes).

From spring to autumn, the individual number of Cladocera was the highest in the Kőhegyi-tó. In spring and autumn *Chydorus sphaericus*, in

summer 1999 *Kurzia latissima* and *Alonella excisa*, in summer 2000 *Scapholeberis mucronata, Daphnia obtusa* and *Ceridaphnia reticulata* were predominant. In August, 2000 an ostracod, *Notodromas monacha* with a 90% juvenile population became extremly abundant in the desiccating lake.

Three times out of six sampling, the Unkás-tócsa was completely dry. In August, 1999 *Moina brachiata* was abundant with only several *Cypridopsis elongata* individuals in the water. In spring both *Moina brachiata* and *Ceriodaphnia reticulata* were abundant. Copepoda species were recorded only in April 2000 in the pond.

Due to continuous presence of diverse and abundant macrophyte stands, macrophyte-associated Cladocera communities predominated in the Kőhegyi-tó in all seasons. In 1999-2000, ten Cladocera species were found from the list of Nógrády (1962), which contained twenty species. Six species (*Alona protzi, Daphnia magna, Graptoleberis testudinaria, Leydigia acanthocercoides, Disparalona rostrata, Pleuroxus trigonellus*) from the 1956 list could not be found in any of the investigated small water bodies of the Pilis Biosphere Reserve in 1999-2000. Species and individual number of Ostracoda and Copepoda was low during the study period. No abundant spring Copepoda communities with *Cyclops strenuus strenuus* and *Megacyclops viridis* dominance were characterictic for most small water bodies in the Pilis and Szentendre-Visegrád Mountains developed in the Kőhegyi-tó.

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